

WHAT IS CLAIMED IS:

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1 1. A three-axis sensor assembly for use in an elastomeric material, the
2 sensor comprising:
3 a first pair of sensors disposed along a first pair of respective axes that
4 intersect, said first sensors detecting a force in a first direction;
5 a second pair of sensors disposed along a second pair of respective
6 axes that intersect, said second sensors detecting a force in a second direction
7 generally orthogonal to the first direction; and
8 wherein the force measured in the first direction is equal to the
9 difference between the outputs of said first sensors, and the force measured in the
10 second direction is equal to the difference between the outputs of said second sensors.

1 2. The three-axis sensor assembly of Claim 1, wherein the sum of the
2 outputs of said first sensors and said second sensors equals a force in a third direction
3 orthogonal to said first and second directions.

1 3. The three-axis sensor of Claim 1, wherein said first pair of respective
2 axes are generally oriented at a first angle with respect to the first direction.

1 4. The three-axis sensor assembly of Claim 3, wherein said second pair of
2 respective axes is generally oriented at a second angle with respect to the second
3 direction.

1 5. The three-axis sensor assembly of Claim 4, wherein said first and
2 second angles are equal.

1 6. The three-axis sensor assembly of Claim 5, wherein said first and
2 second angles are 45 degrees. *preference*

1 7. The three-axis sensor assembly of Claim 1, wherein said first pair of
2 sensors are disposed on first opposed faces of *a pyramid-shaped body*, and said
3 second pair of sensors are disposed on second opposed faces of said pyramid-shaped
4 body.

1 8. The three-axis sensor assembly of Claim 1, wherein the three-axis
2 sensor is embedded in the elastomeric material. *preferential*

1 9. The three-axis sensor assembly of Claim 7, wherein said body is made
2 of the same material as the elastomeric material. *preferential*

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1 10. A three-axis sensor assembly embedded in an elastomeric material, the
2 sensor comprising:
3 ^(2, 24)
4 a first sensing element generating a first output indicative of strain in a
5 ^(30, 32)
6 a second sensing element generating a second output indicative of
7 strain in a second direction orthogonal to said first direction; and
8 wherein the sum of said first and second outputs is indicative of strain
9 in a third direction orthogonal to both the first direction and the second direction.

1 11. A sensor assembly embedded in an elastomeric material, said sensor
2 assembly comprising:
3 a pair of first strain sensors disposed on first opposed faces of a
4 flexible pyramid-shaped body, said first strain sensors detecting a force in a first
5 direction; and
6 wherein said first strain sensors generate corresponding output signals
7 in response to the force in the first direction, and wherein the force in the first
8 direction is generally equal to the difference between the output signals of said first
9 strain sensors.

1 12. The sensor assembly of Claim 11, further comprising:
2 a pair of second strain sensors disposed on second opposed faces of
3 said body, said second opposed faces adjacent to said first opposed faces, and said
4 second strain sensors detecting a force in a second direction generally orthogonal to
5 said first direction;
6 and wherein said second strain sensors generate corresponding output
7 signals in response to the force in the second direction, and wherein the force in the
8 second direction is generally equal to the difference between the output signals of said
9 second strain sensors.

1 13. The sensor assembly of Claim 12, wherein a sum of the first output
2 signals and the second output signals is indicative of a force in a third direction is
3 orthogonal to the first and second directions.

1 14. The sensor assembly of Claim 11, wherein said body is made of the
2 same material as the elastomeric material.

1 15. The sensor assembly of Claim 11, wherein said body has a body
2 hardness greater than the hardness of the elastomeric material.

1 16. The sensor assembly of Claim 15, wherein the hardness of the
2 elastomeric material is generally between 50 and 70 on the Shore A hardness scale. *preference*

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1 17. ~~The sensor assembly of Claim 16, wherein body is made of one~~
2 ~~polyamide, urethane and epoxy.~~

1 18. The sensor assembly of Claim 11, wherein said first strain sensors are
2 parallel plate capacitors. *preference*

1 19. The sensor assembly of Claim 11, wherein said first strain sensors are
2 piezoresistive silicon strain gauges. *preference*

1 20. The sensor assembly of Claim 11, wherein said first strain sensors are
2 piezoelectric devices. *preference*

1 21. The sensor assembly of Claim 20, wherein at least one of said
2 piezoelectric devices is one of PZT, ZnO, and PVDF. *preference*

1 22. The sensor assembly of Claim 11, wherein said first strain sensors are
2 interdigitated finger capacitors. *preference*

1 23. The sensor assembly of Claim 13, further including a plurality of
2 sensor assemblies embedded in an object in a mutually spaced relationship. *preference*

1 24. ~~The sensor assembly of Claim 23, wherein the object is a tire.~~

1 25. The sensor assembly of Claim 24, further including a bus to
 2 communicate signals generated by the plurality of sensor assemblies.

1 26. The sensor assembly of Claim 25, wherein said bus is a five-wire bus.

1 27. The sensor assembly of Claim 24, wherein a contact region is defined
 2 at a position where the tire contacts a surface. B

1 28. The sensor assembly of Claim 27, wherein, when the tire is operation,
 2 each of the plurality of sensors passes said contact region at a different time.

1 29. The sensor assembly of Claim 11, wherein the elastomeric material
 2 comprises a tire.

1 30. A process of embedding a three axis sensor in an elastomeric material,
 2 the process comprising:
 3 providing a three-axis sensor including two pairs of strain gauges, a
 4 first pair disposed on first opposed faces of a pyramid-shaped body and, a second
 5 select pair disposed on second opposed faces of said pyramid-shaped body;
 6 adjusting the aspect ratio of the pyramid to the sensitivity of the three-
 7 axis sensor.

1 31. The process of Claim 30 further including the step of adjusting the
 2 hardness of the pyramid-shaped body relative to the elastomeric material.

1 32. The process of Claim 30, wherein the sensor is introduced to the
 2 elastomeric material when the elastomeric material is in an uncured state.

1 33. The process of Claim 30, further including the step of encapsulating
 2 three-axis sensor in a second material different than the elastomeric material.

1 34. The process of Claim 33, further including the step of selecting a ratio
 2 of elastic moduluses between the elastomeric material and the second material.

1 35. The process of Claim 34, wherein the second material is one of
 2 polyimide and epoxy.

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